REMARKS

CLAIM AMENDMENTS

Applicants have canceled all of the previously presented claims 1-124 and substituted claims 125-142. There are now pending in the application three independent claims; namely, claims 125, 135 and 138. The remaining claims depend from the three independent claims. Eighteen (18) claims are now presented.

PARAGRAPHS 1-21 OF OFFICE ACTION

Paragraphs 1-21 of the Office Action are directed to objections raised pursuant to assertions of double patenting. These are obviousness type double patenting rejections. With respect to co-pending application Serial No. 10/360,204 and co-pending application 10/503,505 as well as co-pending application Serial No. 10/861,593, applicants enclose herewith a terminal disclaimer. With respect to the balance of the rejections, applicants respectfully traverse those rejections as inapplicable. The basis for the inapplicability is that the claimed subject matter of the present invention is believed patentably distinct from the various remaining references. Discussion in this regard is set forth in greater detail hereinafter.

CLAIM REJECTIONS

Briefly, the invention is related to a new class or family of structural, stainless steel alloys having extremely high toughness and strength. The present application sets forth claims for high strength, tough, stainless steel alloys including nickel (Ni) in the range of greater than about 2.5% by weight in combination with other elements and having a distinctive microstructure. Thus, there are a series of characteristic features associated with the claimed alloys above and beyond the mere recitation of the constituent elements. Specifically, the alloys are corrosion resistant, carbon steel

alloys having a carbon content in the range of about 0.15 to 0.30% by weight carbon. The alloys include cobalt, nickel, chromium and minor constituent elements including molybdenum and optionally vanadium, tungsten and other constituents. The balance is iron and potentially incidental elements and impurities. For example, Mn in an amount less than about 1.5% by weight and Si may comprise incidental elements or impurities.

The claimed alloys have a predominantly lath martensite microstructure. Retained austenite, for example, is desirably minimized. Topologically close packed intermetallic compounds or phases are substantially excluded from the microstructure to ensure toughness and resist fracture. The carbon is in the form of a dispersion of nanoscale, predominantly M_2C carbide particles. The carbide particles typically have a nominal dimension less than about 10 nanometers in diameter. The carbide particles are characterized as principally comprised of carbides of chromium and molybdenum and optionally, other elements and facilitate strengtsh. Thus, an important characteristic of the alloys is their high tensile strength which is greater than about 260 ksi. Toughness is another important and concomitant characteristic of the alloys as more specifically characterized, for example, in proposed claim 179[?]. Toughness is considered inherent in the context of the microstructural limitations of the parent claims and likewise, the concomitant strength characteristics are considered inherent.

The Examiner referenced numerous prior art references in paragraphs 12-34 of the Office Action and rejected the claims pursuant to 35 USC Section 103. Applicants acknowledge the interview conducted with the Examiner on November 17, 2005 at which time one of the inventors, Dr. Kuehmann, and counsel presented information and otherwise discussed the subject matter of the application with the Examiner. Applicants express gratitude for the courtesies extended by the Examiner.

PAGE 13/19 * RCVD AT 12/30/2005 3:07:07 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/27 * DNIS:2738300 * CSID:13124635001 * DURATION (mm-ss):07-36

With respect to the various prior art references, applicants distinguished those references as summarized hereinafter. These distinguishing characteristics apply individually to the references and in combination.

PATENT NOS. 6,176,946; 6464,801; AND 6,485,582

These patents, issued in the name of Kuehmann, Olson, Wise and Campbell, disclose case carburizing secondary hardening steels. It is noted, however, that the chromium levels of these steels are in the range of 3.5 to 9% and the alloys may not contain sufficient chromium for corrosion resistance. These alloys are especially adapted for case hardening, where high strength is only achieved in the enriched carbon case at the expense of toughness while the lower carbon core exhibits lower strength where toughness is required. As a consequence, the nickel content is limited in the high chromium examples. The concomitant combination of strength and corrosion resistance with adequate toughness characterized by the formulation and microstructrue of the presently presented independent claims in the present application is, therefore, missing from the prior art.

For example, in column 7, lines 20-35, the reference text discusses the combination of nickel, chromium and cobalt. The example of an alloy with 5% chromium indicates that nickel must be limited to less than 3.5% with cobalt being as high as 25%. Table 1 at column 8, the closest example of the alloys within the ranges described in the current application, discloses chromium at 9% but the nickel is limited in that circumstance to 1.5%. Thus, the subject matter disclosed in the reference series of patents is limited to a situation wherein the case hardened alloys described do not meet the microstructural, compositional, strength and toughness requirements of a monolithic, corrosion resistant, structural stainless steel as claimed in the present application. The patents, for example, do not teach the feature of the general absence of a topologically close packed intermetallic phase or

compound. Such absence is a deemed requisite in order to achieve the strength and concomitant toughness characteristics in the presently claimed alloy.

PATENT NO. 6,458,220

This patent in the name of Kuehmann, Bernikowicz, Olson and Wise discloses case hardened steel blade alloys. The alloys may not contain sufficient chromium for corrosion resistance and fall substantially into the same category of case hardened alloys described with respect to the references discussed above. The teachings of this patent are also deficient with respect to disclosure of alloys having adequate inherent toughness and strength characteristics.

PATENT NO. 6,491,767

This patent to Kuehmann also falls into the category of case hardened steels discussed above and is distinguishable for the reasons set forth.

PATENT NO. 5,310,431

This patent discloses a creep resistant, precipitation dispersion strengthened, martensitic stainless steel. The strengthening precipitate is MX and not an M_2C carbide. The strengthening concept thus is entirely different from that set forth in the presently claimed invention. For example, at column 2, lines 7-25 there is a discussion of the strengthening phase being an MX type as opposed to an M_2C strengthening feature.

PATENT NO. 5,358,577

This patent was not mentioned in the Office Action but was discussed during the interview. This patent to Uehara, Watanabe, and Nakama discloses a high strength and high toughness martensitic stainless steel. The alloys of this patent are not heat treated to provide M_2C particulates.

PAGE 15/19 * RCVD AT 12/30/2005 3:07:07 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/27 * DNIS:2738300 * CSID:13124635001 * DURATION (mm-ss):07-36

The resulting strength is much lower and the ductility and toughness referenced is achieved at a much lower strength due to the failure to arrive at an M_2C carbide particle hardening microstructure.

PATENT NO. 6,117,388

This patent to Shibata, Takashi and Maeda discloses a hot working die steel. The alloy does not contain sufficient nickel for toughness and therefore is distinguishable. Specifically, the range of nickel is less than 1.5% by weight. Note this reference was not discussed in the current Office Action.

JAPANESE PATENT NO. JP6-65692

This patent by Hiroaki discloses a precipitation hardened stainless alloy. The alloy does not contain an appropriate combination of carbon and nickel to achieve the desired tensile strength with good toughness. Reference to the specification of this reference indicates that the microstructure is quite different and the strengthening model is also quite different. That is, strengthening is achieved with a combination of carbide and intermetallic compounds (see paragraph 5). It is not disclosed whether the carbide is an M_2C carbide. The reference relies upon the inclusion of intermetallics such as molybdenum rich phases in Example 3. By contrast, as set forth in the currently submitted claims, there is an absence of topologically close packed intermetallic compounds inasmuch as they promote brittle fracture.

The avoidance of intermetallic phases as taught and claimed in the present application is an important feature in order to achieve useful strength in combination with toughness. To the contrary, the Hiroaki reference teaches that to achieve such strength levels intermetallics are required. However, they are detrimental to ductility and toughness and thus contrary to the present application claims, which calls for their effective elimination from the microstructure.

PAGE 16/19 * RCVD AT 12/30/2005 3:07:07 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/27 * DNIS:2738300 * CSID:13124635001 * DURATION (mm-ss):07-36

It is also noted that in the examples given in this patent the amount of carbon is less than 0.15 weight percent for the higher chromium values are set forth. Example 3 reaches very high strength levels but has a high molybdenum content greater than 4% and a very low nickel content less than 1.5%. Further, this alloy has low ductility as shown in Table 2. For all of these reasons, the reference is inapplicable.

<u>CAMPBELL REFERENCE</u>

The discussions with the Examiner during the interview focused on alloys identified as V96-30-1, V96-30-2, 1605-8A and 1605-8B. The V96 alloys are described at page 159, Table 7-1. They have a low Ni content and were intended for case hardening. These alloys do not possess the capability to achieve the combined strength and toughness required for a monolithic structural alloy as evidenced by the reported toughness values of 22.2 ksi $\sqrt{in}$ and 26.9 ksi $\sqrt{in}$ on page 163 of the report.

Alloys 1605-8A and 8B are similar to each other but only detailed data is discussed for Example 8B. The toughness of 8B is reported to be 27.5 mpa $\sqrt{m}$ at page 165 when tempered to a hardness of HRC 50.6. In subsequent discussion it is revealed that example 8B was decarburized to reduce its hardness and promote ductile fracture. At page 169 the conditions of decarburization indicate a carbon content less than 0.1% is disclosed. While some of these conditions show reasonable toughness levels, they are all achieved at a very low strength as evidenced by the hardness of less than 373 VHN. The one condition that does show good strength and toughness properties is tempered at 200°C. This alloy, however, does not contain M_2C alloy carbides. Rather epsilon carbide (Fe_2C) is expected at this temperature since substitutional diffusion does not occur at such

Banner & Witcoff, Ltd.
Ten South Wacker Drive
Chicago, IL 60606
(312) 463-5000
484860

Serial No. 10/071 688
Attorney Docket No. 04019.00021

PAGE 17/19 * RCVD AT 12/30/2005 3:07:07 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/27 * DNIS:2738300 * CSID:13124635001 * DURATION (mm-ss):07-36

low temperatures. Thus, the teachings do not anticipate or render obvious the presently claimed subject matter.

It is noted that one of the features of the present invention is the effectively complete dissolution of cementite (Fe_3C). The cementite dissolves during the formation of the M_2C carbides. This process is effectively complete when the alloy has progressed beyond a peak in hardness. In high chromium corrosion resistance steels, residual Fe_3C may remain in the microstructure but it represents less than 20% of the alloys carbon content. Consequently, one of the features of the invention is effective elimination of cementite.

Again, another one of the features of the independent claims submitted herewith is the feature of a microstructure essentially without topologically close packed intermetallic phases. It is noted that during a high temperature treatment, such as tempering, intermetallic phases detrimental to toughness, can form in alloys with high contents of chromium, molybdenum and tungsten. These phases, some of which are commonly referred to as a sigma or mu phase, initiate cleavage fracture when subjected to tensile stress. Thus, in structural alloys that experience such stresses, these phases must be absent. On the other hand, it is noted other phase precipitation of metallic phases as opposed to intermetallics may be beneficial. For example, chromium and copper can be tolerated or may be beneficial if the particles sizes are sufficiently fine. However, intermetallic compounds or chemical compounds are to be avoided. It is for this reason that the claim language set forth in the independent claims includes, as a feature, the substantial absence of topologically close packed intermetallic phases in the microstructure. This, in the claimed combination, is a feature not taught by the prior art.

SUMMARY

In view of the foregoing amendments and remarks, therefore, it is believed that all of the references, taken alone or in combination, fail to set forth the key features and elements which constitute the subject matter of the invention. Applicants, therefore, respectfully request reconsideration of the claims as presently presented and amended and passage thereof to allowance.

Respectfully submitted,

Jon O. Nelson

Date: December 30, 2005 By: ______________________

Jon O. Nelson
Reg. No. 24,566

Banner & Witcoff, Ltd.
Ten South Wacker Drive
Chicago, IL 60606
(312) 463-5000
484860

PAGE 19/19 * RCVD AT 12/30/2005 3:07:07 PM [Eastern Standard Time] * SVR:USPTO-EFXRF-6/27 * DNIS:2738300 * CSID:13124635001 * DURATION (mm-ss):07-36